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ABSTRACT

The multivariate effect of task sequence, memory support, and state anxiety was investigated using a nonverbal concept acquisition task. Ninety-five Indian college students were randomly assigned to four treatment conditions resulting from the task sequences of 1) easy-to-hard and 2) hard-to-easy and from memory support versus nonmemory support. Results showed that subjects receiving the easy-to-hard sequence did significantly better on the performance test than did those receiving the hard-to-easy sequence. Also, the memory support treatment groups had significantly fewer errors on the performance test than did the nonmemory support groups. The instructional condition of easy-to-hard sequence plus memory support was the optimal treatment and provided manipulatable variables for applied usage. (Author)

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Concept Learning as Processed by Task Sequence and Memory Support

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ABSTRACT

The multivariate effect of task sequence, memory support, and state anxiety was investigated using a nonverbal concept acquisition task. Ninety-five Indian college students were randomly assigned to four treatment conditions resulting from the task sequence, easy-to-hard and hard-to-easy, and memory support versus nonmemory support. Results showed that subjects receiving the easy-to-hard sequence did significantly better on the performance test than the hard-to-easy sequence ($p < .01$). Also, the memory support treatment groups had significantly fewer errors on the performance test than the nonmemory support condition ($p < .01$). The instructional condition of easy-to-hard sequence plus memory support, as the optimal treatment, provides manipulatable variables for applied usage.

Concept Learning as Processed by Task Sequence and Memory Support[1]

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Research studies (Tallmadge, Schearer, & Greenberg, 1968; Dunham & Bunderson, 1969; Merrill, 1970; Tennyson & Boutwell, 1973c) have indicated that disordinal interactions between personality variables and task conditions have an elusive nature. These studies, which are dependent on task difficulty, have lacked explicitly stated empirical procedures to govern item difficulty. Such procedures are necessary for accurate testing of the theoretical assumption of an anxiety and cognitive interaction. In a recent study by Tennyson and Boutwell (1973b), a system was used in which an empirically based difficulty level was assigned to a concept learning task. Two critical attributes of an anxiety-by-task interaction study were found to be essential: measured anxiety differences, and an empirically based task difficulty contrast. Their study, using a multivariate data analysis, showed that subjects receiving an easy-to-hard sequence had significantly higher scores on the learning task than subjects receiving the reverse sequence. Also, within-task state anxiety measures resulted in a hypothesized disordinal interaction between the two sequence groups. Generalizing these results to an individualized environment of task difficulty, sequence might indicate differential treatments for learners of varying anxiety levels.

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Learners reporting high state anxiety are likely to employ random acquisition strategies and make random choices on a performance test when not given self-reinforcement (memory support)(Wolfgang, Pishkin, & Lundy, 1962). Sieber, Kameya, and Paulson (1970) concluded that highly anxious learners are neither "...cautious nor accurate problem-solvers..." when critical information is not available. Research has suggested (Boutwell & Tennyson, 1973) that the difference between performance in high anxiety and low anxiety learners may be related to the amount of self-reinforcement or memory support they receive during a task. In a functional individualized program, memory support allows the learner to return to the learning stimulus during the performance test.

Hypotheses

The purpose of this study was to investigate the effect of state anxiety on task difficulty sequencing and memory support. The first hypothesis was a replication of the Tennyson and Boutwell (1973b) study which showed the significant effectiveness of the easy-to-hard sequence task. The extension was the inclusion of a memory support condition in the treatment condition. Along with the combination of the sequence variable and memory support variable, a further extension involved the use of a multivariate analysis design using three repeated state anxiety measures and two task performance test measures. The optimal treatment, in terms of test performance, was hypothesized to be an easy-to-hard sequence plus memory support. A third hypothesis was that task sequence would affect within-task anxiety levels, resulting in a disordinal interaction.

Method

Subjects. The subjects were 96 students chosen from undergraduate Indian education classes at Brigham Young University who were randomly assigned to experimental treatments. Subjects volunteered and were paid for their services. No experimental group had a disproportionate number of males to females. The range of ages within these groups was from 19-27 years.

Learning task. The behavioral objective for this task required subjects after reading a definition that included two prompted examples and two prompted nonexamples, to identify examples of RX_2 crystals from a list containing new examples and nonexamples. A prompted instance is one in which each critical attribute is individually separated, identified, and defined. A definition (critical attributes) of RX_2 crystals was presented to the subjects for the task, drawing their attention to the basic repeating two-to-one ratio in the crystal structure of the atoms. This concept was further elaborated as follows: "For a given atom there will be another two atoms attached to it in a repeating fashion." The subjects were also told that symmetry of the crystal was irrelevant. Each page of each task consisted of a single shaded crystal picture taken from Crystal Structures by Wyckoff (1968).

In order to obtain empirical validation of the task difficulty level, competitive response strength of hard and easy items, Tennyson and Boutwell (1973a) defined an item difficulty analysis for rating and categorizing all the instances of the proposed task according to how hard they were for the subjects to recognize. The concept, RX_2 crystals, identification task was formulated according to this analysis. Then it

was administered to 100 subjects from the same target population as the one used in the experiment. Each instance to be used in the task was tested for competitive response strength. Easy items, strong correct response, were those instances correctly identified by 70 percent or more of the subjects. Hard items, strong incorrect response tendencies in competition with the correct response, were those instances correctly classified by less than 30 percent of the subjects. During the treatment, all subjects received successively a hard/easy or an easy/hard segment and each segment had 20 examples and 20 nonexamples. This concept was used because the task had to be a previously unencountered concept and none of the subjects reported any previous knowledge of RX_2 crystals.

The independent variable of memory support involved either permitting or barring subjects from returning to the RX_2 crystal definition and the prompted examples and nonexamples. The two difficulty levels of the task, hard and easy, were crossed with the two conditions of memory support. Being able to return was, in effect, supplying additional information to the subject since concept identification strategies may very well depend on subject self-feedback. Feedback was only possible in the memory support condition. The memory support versus nonmemory support condition was introduced only after the task had begun.

Anxiety measures. The Spielberger, Gorsuch, and Lushene (1969) State-Trait Anxiety Inventory (STAI) was used to measure trait and state anxiety. The A-Trait (Form X-2) Scale asks subjects to indicate how they "generally feel," while the A-State (Form X-1) Scale requires subjects to indicate how they feel "at this moment." The scales, consisting of 20 items, were printed on opposite sides of the questionnaire, Within

the two tasks a five-question A-State scale was used: I am tense; I feel at ease; I am relaxed; I feel calm; I am jittery.

Procedure. Each experimental treatment was administered individually. When finished with the first A-State survey, the subjects returned it to the experimenter to be scored. The subjects were then placed into one of three anxiety levels: low, medium, and high. After being assigned to their initial anxiety level, the subjects were randomly assigned to one of four possible treatments of the factorial design. The treatments were contained in color-coded self-instructional booklets.

The booklet introduction identified the experimenter and the department conducting the study, with directions following. Directions explained the method of responding on the IBM answer sheet. Next, instructions for memory support stated explicitly whether the subject could return to the prompted examples and nonexamples or not. The experimenter was always present to help ensure compliance with the instructions and to control the environmental setting. Following the instructions came the prompted examples and nonexamples pointing out the critical and irrelevant concept attributes. Subjects then classified ten new examples and ten nonexamples for the first task. After the subject had identified these twenty new instances, he was administered the second A-State survey to measure how he felt during the first task. A second task was taken and concluded with the third STAI A-State measuring how the subject felt during the second task. The final page thanked the subject for his time and asked him to return the materials to the experimentor.

Results

Five dependent variables were analyzed using a multivariate statistical design. These variables were: the correct total scores on the easy and hard crystal identification tasks; and the three STAI A-State Scale scores. Statistical power values were derived according to procedures outlined in Cohen (1969). A medium effect size of .25 was established for all data analyses. An alpha level of .01 was predetermined for all tests to keep beta sufficiently small for the N size used in the experiment. Two independent variables, task sequence and memory support, were factored into four treatment groups. The tasks and A-State (2) and (3) means for groups III and IV have been reversed for analysis purposes (see Table 1). The multivariate analysis of variance resulted in a statistical difference between the four groups ($U > .31$, $df = 5/3/88$, power = .99).

Task sequence. Combining the two task scores, the overall performance score means showed the two easy-to-hard sequence groups doing significantly better, with a mean score of 26.14, than the hard-to-easy groups, with a mean score of 18.60 ($U > .59$, $df = 2/1/88$, power = .88). A second hypothesis was a univariate test comparing the groups on the easy task. The result was a significant difference between the two sequences, with the easy-to-hard sequence having a mean correct score four points higher than the hard-to-easy sequence ($U > .60$, $df = 1/1/68$, power = .79). The size of the difference in mean scores between the two sequences on the easy task results in significance with any multivariate hypothesis test. A second univariate hypothesis test on the hard task

TABLE 1

Multivariate Means

Treatment Groups	Dependent Variable Measures				
	A-State (1)	Easy	A-State (2)	Hard	A-State (3)
Easy - Hard Memory	35.8	15.7	43.8	12.7	41.2
Easy - Hard Nonmemory	36.2	12.4	40.7	11.4	41.9
Hard - Easy Memory	36.3	11.5	40.6	8.2	42.3
Hard - Easy Nonmemory	36.8	10.3	43.6	7.3	44.3

showed that the easy-to-hard sequence was significantly better on the task than the other sequence ($U > .62$, $df = 1/1/88$).

Memory support. This study investigated the variable of memory support by designing a condition similar to the prior studies (not allowing subjects to return to the instructions) and a second condition which directed subjects to return to the instructions when needed. Using the multivariate hypothesis blocking on memory support, a significant U resulted with the memory support condition, with a total score of 24. This has a higher correct score than the nonmemory support treatment, mean of 20.7 ($U > .79$, $df = 2/1/88$, power = .68). A univariate analysis was performed on each task with the memory support having a significantly higher score on both tasks; easy task ($U > .76$) and hard task ($U > .86$).

STAI A-State. The measure of subject state anxiety was a dependent function of sequence and task demands within the experimental treatments. The first measure of A-State was administered to the subjects as the first treatment, resulting in no difference of means between the four groups ($U < .99$, $df = 1/3/88$, power = .77). The A-State (1) mean of 36 compares with the average A-State score of 37 reported by the STAI manual (Spielberger, et al., 1969). A-States (2) and (3) were taken following each of the tasks and asked subjects to respond according to how they felt during the task. In both univariate tests on A-State (2) and (3), there was no significant difference between the means ($p > .05$). However, reported A-State did increase after the subjects were performing on the tasks. A-States in both tasks increased to 44, a significant gain after the initial measure.

Optimal condition. The present study extends prior research of task sequence by introducing memory support. The hypothesized optimal sequence and condition was easy-to-hard with memory support. Using a multiple comparision analysis for multivariate data (Morrison, 1967), group I, with a total mean of 28.4, had the highest significant score of the four conditions (see Table 1). The second easy-to-hard group (group II) had the second highest mean, which was significantly better than groups III and IV, which did not differ. When analyzing the two tasks univariately, the easy task mean differences were significant ($U > .56$, $df = 1/3/88$, power = .88), as were the hard task means ($U > .48$, $df = 1/3/88$). On the easy task the multivariate multiple comparison was the same as the total score comparison. On the hard task groups I and II did not differ ($p > .05$), but they did have higher means than groups III and IV (which did not differ).

Discussion

To further test the Spence-Taylor drive theory, which proposes that competing response tendencies interfere with learner performance differentially given a difficult and easy task, was the initial purpose of this study. According to the Spence-Taylor theory, highly anxious learners generate a high level of stimulus-derived anxiety (Sd), the inhibiting aspect of anxiety which mistakenly drives them to the strongest response competing for their attention. Oftentimes, whether the response is correct or not, the highly anxious learner will choose it because of its strength or dominance (Spence, 1958; Taylor, 1956).

The experimental findings of this study did not support the Spence-Taylor theory of disordinal anxiety by task performance hypothesis. The

lack of effect is related to the findings in the STAI A-State anxiety profile analysis which showed nonsignificant difference between A-States (2) and (3). The implication is that in order for the disordinal interaction between performance and anxiety to occur, there first must be a difference in anxiety levels, which did not exist on anxiety test two or three. This is interpreted to mean that since hypothesis three was not supported, the Spence-Taylor competing response theory was not tested as there were no differences in the subjects' anxiety during task performance. On the other hand, the A-State scores (2) and (3) did increase significantly from A-State (1).

The results of the data analysis showed the effectiveness of the easy-to-hard sequence, replicating Tennyson and Boutwell (1973b). These findings indicate that an easy-to-hard sequence does improve performance on the hard task in comparision to a learning task beginning with a hard task. An initially hard task seems to have debilitating effects on succeeding performance in the learning task. Adding memory support to this sequence, an increasingly optimal instructional design for concept acquisition is the easy-to-hard sequence which provides an additional source of information to the learner in the completion of his task. This higher level of classification behavior relieves the learner from memorizing nonrelevant material. These results confirm the value of the memory support condition in obtaining higher correct task scores.

Trait anxiety has been measured with task interaction experiments, and generally has been unsuccessful in supporting the Spence-Taylor disordinal interaction theory (Boutwell & Tennyson, 1973). State anxiety level is task specific. The large amount of contradictory data that exists

concerning the interaction between subject anxiety and task performance appears to be due to the fact that the interaction depends on the anxiety-evoking characteristics of the task, and not exclusively on the subject's anxiety level. Future anxiety-by-task interaction studies will also be contradictory unless controls are adopted to measure anxiety for a specific task. That is, instructional tasks can be empirically designated easy and difficult (Tennyson & Boutwell, 1973a), but until tasks can also be designated as anxiety-evoking on a similar continuum, there is little hope of implementing a generalizable hypothesis concerning the interaction of subjects' anxiety effects during the instructional process and subsequent performance.

This constraint should not detract from the fact that optimal task sequence with memory support provides instructional value by relieving the learner of unnecessary cognitive processing. This anxiety experiment discovered that rather than adapt students' anxiety level to instruction, it would be of more value to improve the parameters of the instructional task, i.e., sequence and feedback. We are suggesting that this validation and revision process in the discovery of the most optimal instructional variables is a more worthwhile process than the adaptation of instruction to idiosyncratic student characteristics.

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